April 7, 1942. N. R. SMITH 2,278,500

VACUUM TUBE SEAL-OFF

Filed Jan. 31, 1941 2 Sheets-Sheet 1

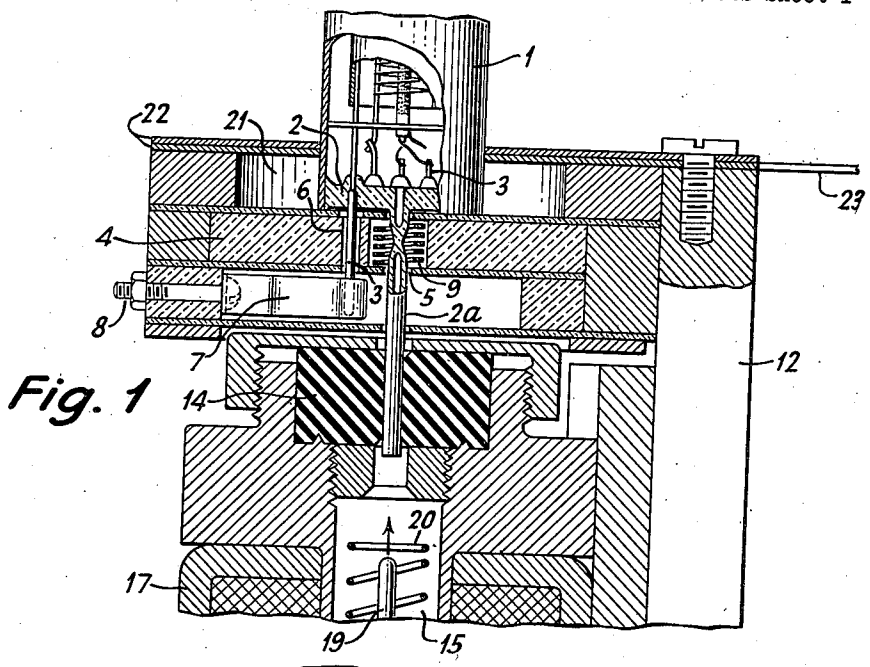


Fig. 1

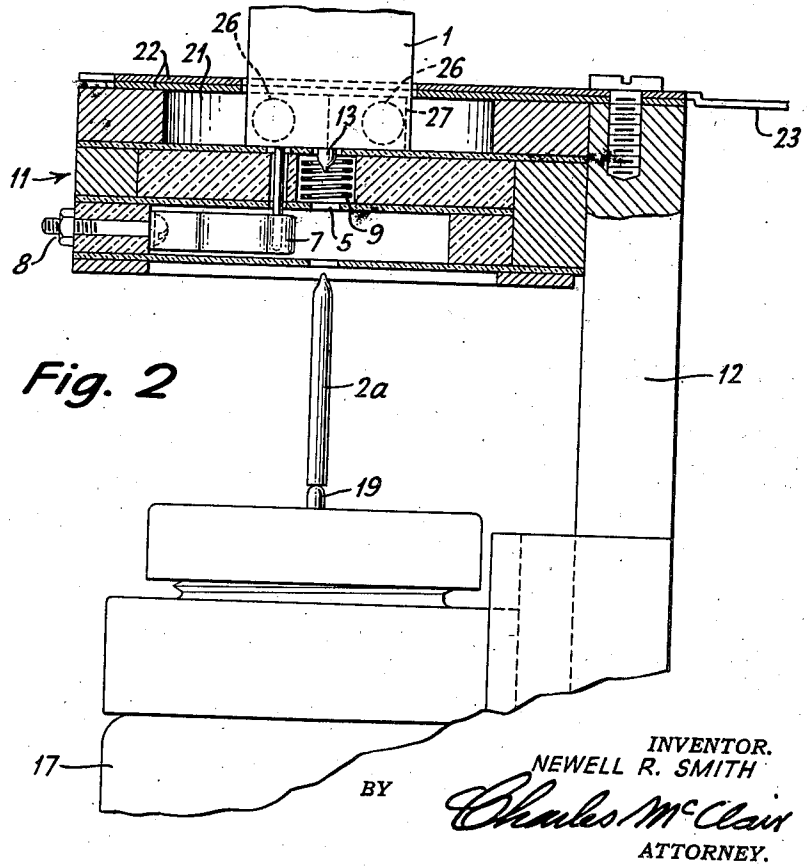


Fig. 2

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Fig. 3

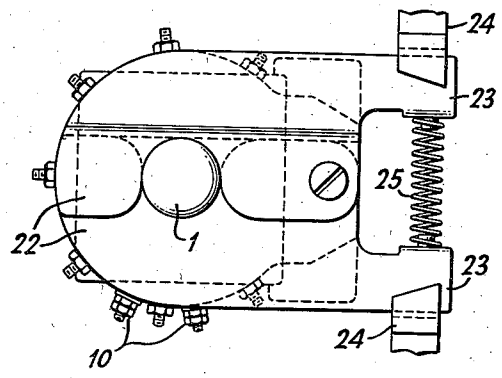


Fig. 4

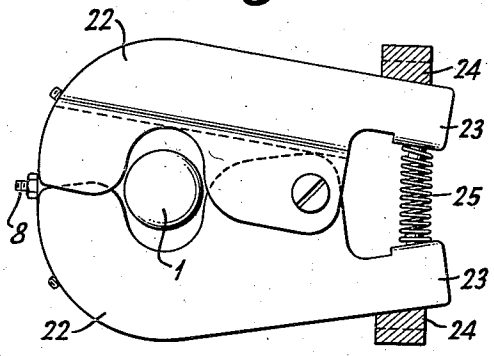


Fig. 6

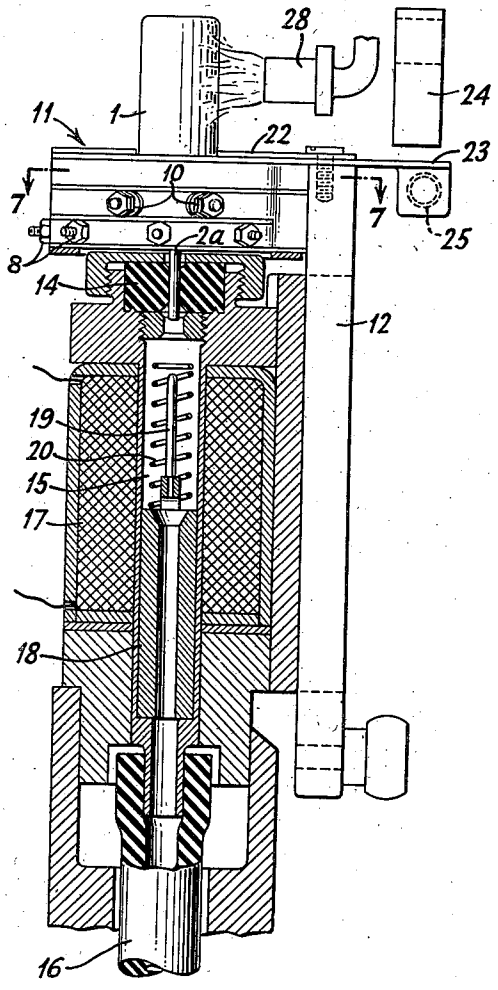


Fig. 5

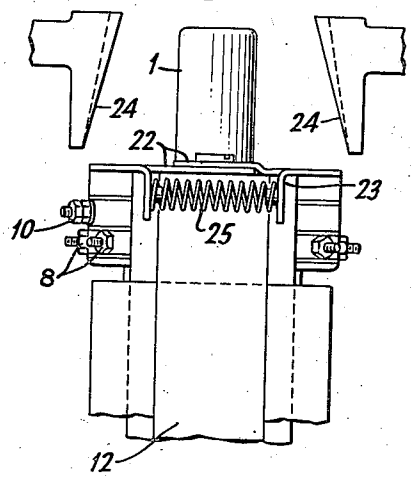
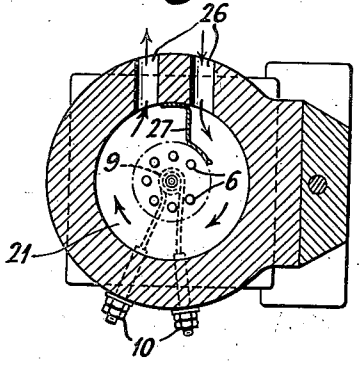


Fig. 7



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UNITED STATES PATENT OFFICE

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VACUUM TUBE SEAL-OFF

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Application January 31, 1941, Serial No. 376,811

9 Claims. (Cl. 250—27.5)

My invention relates to the manufacture of exhausted envelopes such as radio tubes and particularly to means for sealing the exhausted tube of the envelope.

Radio tubes usually comprise an envelope closed at one end with a re-entrant stem or button type glass disc or header with an exhaust tube which must be sealed and tipped off at the completion of exhaust. The exhaust tube is usually pushed into a rubber bushing to make hermetic connection with the exhaust pumps and a machine carrying the bushings is rotated step-by-step to index the envelopes into high frequency coils or gas flames, depending on whether the envelope is of metal or glass. When the envelope is pumped out, so-called "tip off" flames are pointed and directed on the exhaust tube as near to the bulb as possible to melt the exhaust tube and seal it without damaging the envelope. It is desirable of course to make the seal exhaust tube as short as possible. These tip-off flames are slow in raising the glass to melting temperature and because the flames cannot be carried along with the envelope on the exhaust machine, the machine must be brought to rest while the flames melt the tube. This operation usually determines the maximum speed to which the machine may be operated.

The usual exhaust machine, further, is provided with a grooved copper track parallel to the line of travel of the envelope. Long flexible lead-in conductors of the envelope drag along in the track so that when the tracks are energized, electrodes in the tube may be heated or bombarded during exhaust. Where the external ends of the leads are short and stiff, as when they are used as contact pins, the leads cannot be held with uniform pressure against the track. Further, these short stiff leads cannot be bent out of the way of the tip-off fires that must be played on the exhaust tube.

An object of my invention is improved apparatus for sealing off exhaust tubes of envelopes.

A more specific object of my invention is means to seal or tip-off the exhaust tube of a radio tube envelope which will not damage the envelope by heating and which will leave an exhaust tube tip of minimum length.

A still further object of my invention is an improved exhaust machine that will not oxidize lead-in conductors or contact pins, that is not limited in operating speed by the tipping operation, and is easy to operate.

The characteristic features of my invention are defined in the appended claims and the preferred embodiments thereof are described in the following specification and shown in the accompanying drawings in which:

Figures 1 and 2 are elevational views in section of my machine in two operating positions;

Figures 3 and 4 are plane views of my improved tip-off machine showing the machine in the two positions represented, respectively, in Figures 1 and 2;

Figure 5 is an elevational view taken at right angles to the view of Figure 1;

Figure 6 is a side elevational view partly in section of a complete assembly of my improved machine; and

Figure 7 is a sectional view taken along lines 7—7 of Figure 6.

The envelope 1 to be exhausted may be the envelope of a radio tube, as shown in Figure 1, with a conventional button or disc type glass header 2 and an exhaust tube 2a joined to the center of the header. Sealed through the header and concentric with the exhaust tube are the lead-in conductors 3 for the electrodes, the outer ends of the conductors being relatively short and stiff so that they may be used as contact pins on the finished tube. The relatively thick supporting plate 4 of heat and electrical insulating material is provided with a central port 5 just large enough to receive the exhaust tube, and a plurality of holes 6 arranged in a circle concentrically with the port to receive the contact pins. The insulating plate 4 is preferably thinner than the length of the contact pins so that when the tube rests upon the plate, the contact pins protrude from the underside and into contact with spring fingers 7 electrically connected with exterior binding posts 8. An electrical heating coil 9 in the insulating plate and coaxial with the exhaust tube port may be heated by passing current through the coil from binding posts 10 on the tip-off head and apply heat of glass melting temperature to the exhaust tube immediately adjacent the header. The entire tip-off head, generally indicated by reference character 11, is mounted on and may be vertically reciprocated by the carriage piston 12. In operation the exhaust tube is heated by the coil until the tube collapses and, by moving the head upward, the exhaust tube is pulled in two leaving a short tip of glass 13 at the center of the glass header.

The tip-off head overlies the bushing 14 of soft rubber or rubber-like material that will make a hermetic seal with the smooth sides of the glass exhaust tube, and, as better shown in Figure 6,

the exhaust tube communicates through an air-tight pipe 15 with a hose 16 which leads to the exhaust pump. Surrounding the pipe is the coil of solenoid 17 and inside the pipe is a plunger 18 centrally bored to complete the exhaust passage through the pipe. At the upper end of the plunger is provided a push-rod 19 which when elevated by the solenoid will eject the tipped off portions of the exhaust tubes from the rubber bushing. The plunger returns to its lower position by gravity and by a compression spring 20.

To protect the glass header with its large number of lead-in seals from heat during exhaust the lower end of the envelope is enclosed in a chamber 21 through which cooling air is forced. The top side of the chamber is closed by two complementary lids 22 hinged eccentrically of the axis of the head so that it may be opened as shown in Figure 4 to permit the insertion and withdrawal of radio tubes. The cooling chamber lids are each provided with arms 23 beyond their pivot so that they will move to the open position as the head rises on its piston. Two fixed cams 24, Figures 4 and 5, preferably carried on the stationary portion of the machine, are positioned above the arms so that the arms will ride onto the cams and force open the lids as the head rises. Coiled compression spring 15 between the arms biases the lids to closed position. Cooling air is admitted and discharged through ports 26, Figure 7, in the sides of the chamber and is directed in a circular path around the base end of the tube by the baffle 27. In case the envelope is of metal the baffle is preferably of metal spring pressed against the sides of the envelope to ground the envelope to the machine.

A plurality of my novel exhausting and sealing assemblies, as shown in Figure 6, may be mounted on the periphery of the rotating table of a conventional exhausting machine usually known as a "sealex" machine. The machine may be indexed step-by-step or rotated continuously to carry the envelopes of the tubes to be exhausted into the gas flames of burners such as shown at 28, Figure 6, or into high frequency coils. At the loading position the head is preferably in its lowered position with the lids 22 open. As the machine rotates the lids close, and the exhaust pumps commence to evacuate the envelope. Cooling air is admitted and exhausted through ports 26 of the cooling chamber as heat is applied to the envelope to degas the metal parts. Low temperature heat may, if desired, be applied to the exhaust tube by the tip-off coil 9 during exhaust, and near the completion of exhaust current through the coil may be increased suddenly to rapidly melt the exhaust tube glass. The exhaust tube now collapses, sealing the envelope, and the melted tube may be pulled in two by moving the head 11 upwardly. The exhausted and sealed envelope, however, may not immediately be removed from the machine but the heat from coil 9 may be applied until the glass tip 13 balls and sucks in slightly. The exhausted and sealed envelope is then removed and a new envelope inserted. While the head is in the elevated position solenoid 17 is energized, core 18 rises and push rod 19 ejects the tipped off exhaust tube which may be delivered, by a blast of air, to a receptacle. It will be noted that the machine need not be stopped while the exhaust tube is being melted and tipped off since the heat may be applied during any portion of the exhausting cycle. If desired a canopy or hood type oven may be constructed over the line of travel of the envelope to continuously heat the envelope during exhaust and exhausting and tipping off completed without stopping or indexing the machine.

Good results have been obtained in exhausting and sealing radio receiving tubes with metal shells closed by glass button or disc type headers as shown at 2, Fig. 1, where the header may be only .625 inch in diameter carrying a central exhaust tube .137 inch in outside diameter and a circle of nine .04 inch contact pins, and where the heating coil is 8½ to 9½ turns of "nichrome No. 5 ribbon .010 by .031 inch edge wound with an inside diameter of .156 inch. Although the large amount of metal embedded in and surrounding the small glass button would be seriously heated and oxidized if gas flames were played upon the exhaust tube through and between the leads, I have found that the exhaust tube may be sealed and tipped off according to my invention without damage to the pins, header or seals. The temperature of the rim of the head is easily adjusted by the cooling air to 200° to 300° C. during exhausting and sealing.

My improved sealing machine will not oxidize lead-in conductors, is not limited in operating speed by the sealing operation, will not damage the envelope or header by heat, will make a tip of minimum length and is easy to operate at high speeds.

I claim:

1. A machine for exhausting and sealing an envelope having an exhaust tube and a lead-in conductor extending side-by-side from the envelope, comprising a supporting plate of insulating material of a less thickness than the external length of said conductor, said plate having a hole for said conductor and a port for said exhaust tube, a contactor on the under-side of said plate in alignment with said hole for electrically connecting to said conductor, an electrical heating element within said plate and disposed immediately around without obstructing said port, a cooling chamber on the upper side of said plate, an exhaust bushing with a central opening coaxial with said port for making a hermetic connection with the end of said exhaust tube, a reciprocatable push-rod in alignment with the bushing opening, said plate, contactor and cooling chamber being assembled as a unit and movable with respect to said bushing along a line through said port and bushing opening.

2. A device for sealing the exhaust tube of an envelope comprising a supporting plate of electrical and heat insulating material having a port through the plate slightly larger than said exhaust tube, an electric heater within the plate closely surrounding and coaxial with said port without obstructing said port.

3. A machine for exhausting and sealing an envelope with an exhaust tube comprising a bushing of rubber-like material with an opening for making hermetic connection with said exhaust tube, an exhaust pump pipe communicating with said opening, a plunger in said pipe and a solenoid around said pipe, a push-rod on said plunger in alignment with said opening, a tip-off head reciprocatably mounted above said bushing, said head comprising a supporting plate for the envelope to be exhausted, said plate having a port for said exhaust tube in alignment with the bushing opening, means on the side of said plate opposite said bushing for cooling that portion of the envelope adjacent the plate.

4. A machine for exhausting and sealing off an envelope with an exhaust tube comprising a supporting plate with a central port for receiving the exhaust tube, heating means within the plate coaxial with and surrounding said port, a cooling chamber on one side of said plate, said chamber having movable lids to enclose the end of the envelope resting on said plate, means for opening and closing said lids for the insertion and withdrawal of the envelope.

5. An exhaust tube tip-off machine comprising a supporting plate, a port through said plate, heating means coaxial with and surrounding said port within said plate, said heating means comprising a coiled edge wound ribbon of resistance heating metal, the end turn of said coil being closely spaced to one surface of said plate.

6. A device for sealing and tipping off an exhaust tube of an envelope comprising a relatively thick supporting plate of electrical and heat insulating material, said plate comprising two sheets on opposite sides of said plate, said sheets having aligned ports for the exhaust tube, an electrical heating coil embedded in said plate coaxial with said ports with the end turns of said coil closely spaced to said sheets.

7. A machine for exhausting and sealing an envelope with an exhaust tube comprising a supporting plate, said supporting plate having a central port for receiving the exhaust tube, a ring resting on the upper surface of said plate larger in diameter than said envelope, two lids on said ring with complementary notches which fit the outer wall of the envelope for closing a chamber around the end of said envelope, and fluid cooling ports communicating with the chamber between said lids and said plate.

8. A machine for exhausing and sealing a metal envelope with a glass exhaust tube comprising a supporting plate, said supporting plate having a central port for receiving the exhaust tube, a cooling chamber on the upper side of said plate, two lids with complementary notches which fit the outer wall of the envelope for closing said chamber around the end of said envelope, and close spaced fluid cooling ports communicating with the chamber, a metal baffle in said chamber extending from the wall of the chamber between said fluid cooling ports to the metal envelope.

9. A machine for exhausting and sealing an envelope with an exhaust tube comprising a supporting plate, said supporting plate having a central port for receiving the exhaust tube, a heating element in the plate around said port, a ring resting on the upper surface of said plate larger in diameter than said envelope, two lids slidable on said ring with complementary notches which fit the outer wall of the envelope for closing a chamber around the end of said envelope, and fluid cooling ports communicating with the chamber between said lids and said plate, said lids being pivoted on one side of said rings, arms on each lid extending beyond said pivot, and means for moving said arms to open and close said lids over the cooling chamber.

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